Influence of Morphology on the Electrochemical Properties of Proton Exchange Membranes

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In order to examine the relationship between structure, morphology and electrochemical properties of proton exchange membranes, a novel class of copolymers with well-controlled polymer architecture have been prepared.

This hydrocarbon based system enables the control of both the copolymer's ion content and morphology by varying the number and length of block chains. Analogous random copolymers were also synthesized for comparison. The block and random copolymers exhibit very different properties (i.e. mechanical strength, water uptake, and conductivity) which are shown to result from inherent morphological states.

The block copolymer membranes exhibited lower water content but larger proton conductivity for a given sulfonic acid content when compared to the random copolymers (Figure 1). Transmission electron microscopy (Figure 2) showed that the block copolymer membranes exhibited a higher degree of phase separation and enhanced connectivity between ionic domains.

These studies illustrate the importance of phase separation on ionic conductivity and water sorption. Although the stability of hydrocarbon based proton exchange membranes are inferior than perfluorinated materials (i.e. Nafion), the information regarding the role of morphology on proton conductivity should be important in the design of new ion exchange membranes for fuel cell applications.

ACKNOWLEDGEMENTS

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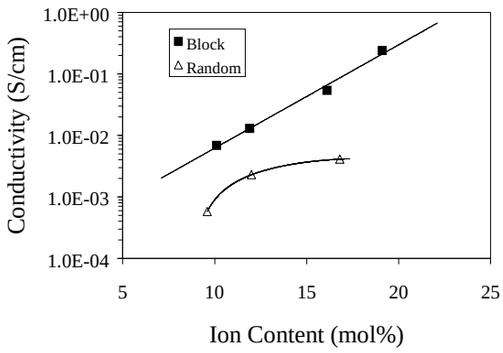

Figure 1. Proton conductivity of block and random copolymers as a function of ion content.

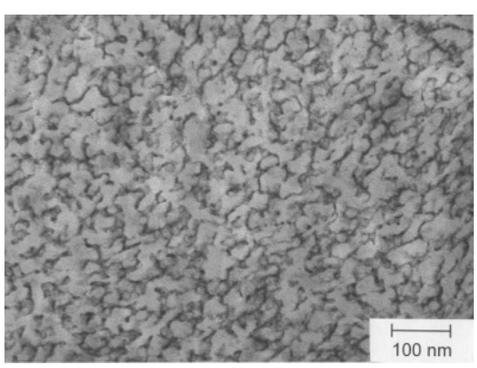

Figure 2. TEM micrograph of a block copolymer membrane with ion content 11.9 mol%